50037

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SPECIAL STUDY REPORT COVERING

INSPECTION OF 552A-101

To determine existing alignment condition and feasibility of increasing system's measuring accuracies.

STAT

Declass Review by NGA.

Submitted by:

STAT

PURPOSE OF FEASIBILITY STUDY

To determine the condition of existing 552A-101 Viewer System and what approach could be taken for rework and alignment to provide mensuration capability.

Namely:

2.5 microns $\pm$ .005% of distance traveled

1) Analyze historical data, inspect and test 552A System on site.

2) Submit report of findings

Summary of 5 and 6 November 1969 field trip inspection findings:

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STAT X-Y objective motions were collimated both for azimuth and elevation. Measurements were also made using [redacted] 9 X 18 inch calibrated grid. Right format shows the following gross readings and observations:

ITEM	ΔX AXIS (8") LEVER	ΔY AXIS (5") LEVER
Azimuth	± 4 seconds ARC	± 7 seconds ARC Accuracy
Elevation	-4 to + 32 seconds	± 5 seconds
Coordinate Measurements	+ 10 μ to - 39 μ	-5 μ to +28 μ
Perpendicularity	600 μ	Roughly adjusted same to approximately 160 microns of being perpendicular
Backlash over Random Points	0 to 2 μ Operator positioning error possible	0 to 2 μ
Drift Repeatability	3 to 4 microns after 1/2 hour warm up. No drift recorded after approximately 1 - 2 hours of warm up. Warm up precautions must be observed.	
Screw Errors	Contained in composite coordinate error readings above. Records show screws good to 5 microns/foot and within tolerance over incremental 3" and 4" distances.	
Cable Forces	No errors in repeatability were noted under normal operation. Manually induced forces gave 1 to 10 micron movements.	
Level Check	System was found to be reasonably level and not the cause of drift.	

ITEM	Δ X AXIS (8") LEVER	Δ Y AXIS (5") LEVER
Focus Variations	Due to variations in way elevation and possibly platen being out of level	
X-Y Motion Stuttering	Normal at certain cross over speed cleaning and lubrication will help	
High Magnification Illumination	Solenoids not working; left objective turret binding;	
Film Guide	Repair Required	

Analysis of Archive Records and Historical Data

Investigation of drawings and inspection records show that all components such as; screws, ways, ball bushings, bearings, carriages and miscellaneous components met all tolerances and quality standards.

552 PTD way mounts and carriage members were likewise selected, form fitted, lapped and/or finish honed, and scraped and finally aligned with collimators to within 2 seconds of arc so that final composite accuracies would fall within the targeted requirements. Inspite of these precautions, additional system alignments were required at the final installation to cancel out certain inaccuracies due to relocation, releveling and other composite errors.

General Background History

The 552A Models 101, 102, 103 and 104 were built as multi-purpose comparison and viewing instruments with special optical switches and drives to permit multi-mode viewing, scale matching and scanning film chips or double spooled imagery. The 552 point transfer device was likewise equipped, but in addition, contained extras such as selected components; precision machining and alignment to provide accurate mensuration capabilities as well as laser marking optics and associated precision alignments. All 552 and 552A Models were equipped with cast iron base structures and 5/4 per foot lead screws. Because of accuracies required by the 552PTD considerable work was put into the initial machining, preparation and collimation of all ways and mounts.

SUMMARY

Based on inspection findings and investigations summarized above, it is obvious that alignment of ways, carriages, and miscellaneous components is required to improve the system measurement accuracies.

Y Way collimation plot of elevation shows linear Y measurements can be improved by re-aligning Y ways.

X Way collimation plot likewise shows that linear X measurements can be improved by re-aligning X ways.

Y Way Azimuth collimation plot indicates rough high spots that should be removed to improve measurement accuracies.

Perpendicularity 600 micron shift was recorded; this was lowered to about 160 microns during inspection, but will require further alignment and work to meet the design goal accuracies.

It naturally follows that the degree of accuracy set as a working goal or target will determine the approach taken.

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APPROACH A

A ± 2.5 microns ± .005% system would require return to STAT [redacted] plant facilities for complete disassembly, inspection, probable replacement of ways, bushings, rework and lapping of way mounts, recollimation and alignment of bare ways upon surface plate to establish a basic in line working plane. Re-asembly and test to determine final accuracies are within ± 2.5 microns ± .005% as a design goal. Correction cams could possibly be required.

System would then be shipped and installed at final site and retested. While the lead screws will be cleaned, lubricated and inspected, replacement of same is not contemplated or estimated based on feasibility study. Task would require approximately 16-20 weeks from receipt of system to final re-installation and test at site.

1600 to 2000 hours to dismantle

Cost: ≈ 40-43K plus cams if necessary
(cams x 25-30K)

APPROACH B ≈ 12.5K

A ± 8 microns ± .005% system would be reworked and aligned at Washington site without complete disassembly and bottom up alignment as would be provided at factory facility. Tasks would include:

1. Complete cleaning and lubrication

2. On spot adjustments and recollimation of all ways and carriages to best possible configuration for orthogonality, flatness, and straightness.

3. Test to determine final accuracies are within ± 8 microns ± .005% as a design goal. It is anticipated that this ±8 micron accuracy may be improved somewhat after certain items are more critically inspected and minute imperfections are corrected.

4. Submit short report at completion of 6 man weeks of field work and tests.

APPROACH C

Allow 2½ μ accuracy. In-house effort. Replace shaft encoder with laser interferometer system. ≈ 12.5K + interferometer (≈ 50-60K ?)

APPROACH D

1 - 1½ μ accuracy. Same as C but returning equipment

STAT to [redacted]

Cost estimates for above will be based upon:

1. Normal daytime working hours, Monday through Friday.

2. Support from your personnel and shop facilities when and if necessary to expedite work.

3. Electronic readout equipment is available and in working condition.

4. No major components require replacement.

STAT 5. [redacted] will employ a grid to check out the format over 25 calibrated points (traceable to Bureau of Standards). No formal calibration is included.